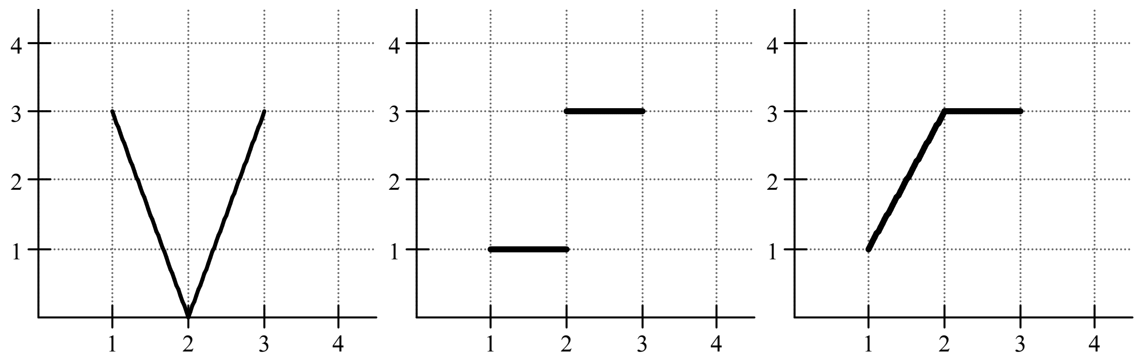
Test questions: **Applications of integration 2 – accumulation, average value, density**

Calculator required for some questions. Show your work.

1. Determine the average value on the closed interval [1, 3] of each of the piecewise linear functions whose graphs are shown below.

A. B. C.



2. A thin rod of length 1 meter has a density of $\left(1-\frac{x}{2}\right)$ grams / meter where x is the distance in meters from one end of the rod. What is the mass of the rod in grams?

3. The velocity of a car is given by $v(t)=20(x+\sin(x))$ miles per hour.

   a. How far does the car travel between $t = 1$ and $t = 3.2$ hours?

   b. What is its average velocity during the time interval [1, 3.2]?

4. For an experiment a hot-air balloon is designed so that its altitude will change at a rate modeled by $r(t)=t^3-12t+4$ where t is measured in hours with $0\le t\le 5$. The experiment is planned to start with the balloon 20 miles above the earth.

   a. Find the time interval during which the altitude of the balloon is decreasing.

   b. Write an integral expression that gives the height of the balloon at any time t.

   c. Find the minimum height of the balloon. What does this tell you about the plans for the experiment?

5. A water tank at Camp Newton holds 1200 gallons of water at time $t = 0$. During the time interval $0 \le t \le 18$ hours, water is pumped into the tank at the rate

$$W(t) = 95\sqrt{t}\sin^2\left(\frac{t}{6}\right) \text{ gallons per hour.}$$

During the same time interval, water is removed from the tank at the rate

$$R(t) = 275\sin^2\left(\frac{t}{3}\right) \text{ gallons per hour.}$$

a. Is the amount of water in the tank increasing at time $t = 15$? Why or why not?

b. To the nearest whole number, how many gallons of water are in the tank at $t = 18$?

c. At what time t, for $0 \le t \le 18$, is the amount of water an absolute minimum? Show the work that leads to your conclusion.

d. For $t > 18$, no water is pumped into the tank, but the water continues to be removed at the rate $R(t)$ until the tank becomes empty. Let k be the time when the tank becomes empty. Write, but do not solve, an equation involving an integral expression that can be used to find the value of k.